UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/526,941 | 09/08/2005 | Arjun G Yodh | UPNA-0034 / P2952 | 7568 |

23377 7590 03/02/2011

WOODCOCK WASHBURN LLP
CIRA CENTRE, 12TH FLOOR
2929 ARCH STREET
PHILADELPHIA, PA 19104-2891

| EXAMINER | |
|---|---|
| MARTINEZ, BRITTANY M | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 1734 | |

| NOTIFICATION DATE | DELIVERY MODE |
|---|---|
| 03/02/2011 | ELECTRONIC |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

eofficemonitor@woodcock.com

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/526,941 | YODH ET AL. | |
| | Examiner | Art Unit | |
| | BRITTANY M. MARTINEZ | 1734 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *07 December 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-139* is/are pending in the application.

4a) Of the above claim(s) *55-139* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-54* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

### *Status of Application*

Applicants' election *without traverse* of Group I, **Claims 1-54**, in the reply filed on December 7, 2010, is acknowledged. **Claims 1-139** are pending in the instant application, with **Claims 55-139** withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. **Claims 1-54** have been examined.

### *Specification*

The disclosure is objected to because it contains an embedded hyperlink and/or other form of browser-executable code. Applicants are required to delete the embedded hyperlink and/or other form of browser-executable code. See MPEP § 608.01.

### *Claim Rejections - 35 USC § 112*

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. **Claims 14 and 49** are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

3. **Claim 14** recites the limitation "said alkyl groups." There is insufficient antecedent basis for this limitation in the claim. The surfactant of **Claim 1** only requires "an alkyl group."

4. **Claim 49** recites the limitation "the singlewall carbon nanotubes." There is insufficient antecedent basis for this limitation in the claim. **Claim 37** only requires "carbon nanotubes," not singlewall carbon nanotubes.

***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

7. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary.

Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

8. **Claims 1-54** are rejected under 35 U.S.C. 103(a) as being unpatentable over O'Connell et al. (*Chemical Physics Letters*) in view of Zaneveld et al. (US 2002/0114776 A1).

9. With regard to **Claims 1, 2, 4-13 and 31-35**, O'Connell discloses a dispersion comprising water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate (O'Connell, Abstract; page 265, 2nd column, 2nd paragraph; page 266; page 268, 2nd column; page 269; page 270, 1st column; page 271, "Conclusions," in particular). The difference between the product of O'Connell and that of **Claim 1** is O'Connell does not explicitly disclose the alkyl group of polystyrene sulfonate having from about 4 to about 30 carbon atoms.

10. With regard to **Claim 3**, O'Connell discloses the single-walled carbon nanotubes are non-covalently associated with the polyvinyl pyrrolidone or polystyrene sulfonate (O'Connell, Abstract, in particular).

11. With regard to **Claims 19-21, 45 and 46**, O'Connell discloses polystyrene sulfonate can solubilize SWNT material up to 4.1 g/l (O'Connell, page 269, 2nd column, last paragraph, in particular).

12. With regard to **Claims 22-24, 27 and 47**, O'Connell discloses most polymer-SWNT complexes consist of a single SWNT associated with the polymer

(O'Connell, page 266, 2nd column, last paragraph; page 267, 1st column, 1st paragraph, in particular). In any event, an expected number percentage of individual SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such number percentage varies. Since the number percentage is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable number percentage of individual SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

13. With regard to **Claims 29 and 50**, O'Connell discloses the weight ratio of carbon nanotubes to polystyrene sulfonate being 2:1 for laser-oven material and 1:2 for HiPco material (O'Connell, page 270, 1st column, 1st paragraph, in particular).

14. With regard to **Claim 35**, O'Connell discloses dispersion in pure water (O'Connell, page 266, 2nd column, 1st paragraph, in particular).

15. With regard to **Claim 36**, O'Connell discloses dispersion in water and 1% sodium dodecyl sulfate (O'Connell, page 266, 1st column, 2nd paragraph, in particular).

16. With regard to **Claims 37 and 44**, O'Connell discloses a method for preparing a dispersion of carbon nanotubes, said method comprising mixing water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate via ultrasonication (O'Connell, Abstract; page 265, 2nd column, 2nd paragraph; page 266; page 268, 2nd column; page 269; page 270, 1st column; page 271, "Conclusions," in particular). The difference between the process of O'Connell and that of **Claim 37** is O'Connell does not explicitly disclose a low-

power, high-frequency bath sonicator or the alkyl group of polystyrene sulfonate having from about 4 to about 30 carbon atoms. However, choosing a specific sonicator would have been a matter of process design and routine optimization for one of ordinary skill in the art at the time of invention and thus, obvious to one of ordinary skill in the art at the time of invention.

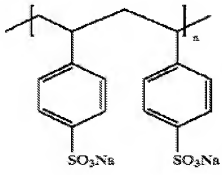
17. With regard to **Claim 47**, O'Connell discloses most polymer-SWNT complexes consist of a single SWNT associated with the polymer (O'Connell, page 266, 2nd column, last paragraph; page 267, 1st column, 1st paragraph, in particular). Thus, while O'Connell does not explicitly disclose the mixing time being selected to give rise to at least about 50 number percent of the dispersed carbon nanotubes being individual SWNTs, the mixing time must have been sufficient to give rise to at least about 50 number percent of the dispersed carbon nanotubes being individual SWNTs.

18. With regard to **Claims 53 and 54**, O'Connell discloses electrophoretically separating the dispersed carbon nanotubes according to length (O'Connell, page 265, 2nd column, 1st full paragraph; 270, 2nd column, last paragraph; page 271, 1st column, 1st paragraph; Fig. 5, in particular).

19. O'Connell does not explicitly disclose the alkyl group having from about 6 to about 20 carbon atoms (**Claim 5**), from about 8 to about 16 carbon atoms (**Claim 6**), or from about 10 to about 14 carbon atoms (**Claim 7**); the aromatic group capable of pi-like stacking onto the surface of the carbon nanotubes (**Claim 9**); a plurality of alkyl groups bonded to the aromatic group (**Claim 14**); the surfactant comprising an alkaline salt of a $C_n$ alkyl benzene sulfonate, where

n is between about 8 and about 16 (**Claim 15**) and the alkaline salt comprises a counterion selected from the Group IA elements or any combination thereof (**Claim 16**) or wherein said counterion is sodium, potassium, or any combination thereof (**Claim 17**); the mean length of individual SWNTs being at least about 120 nm (**Claim 25**), 300 nm (**Claim 26**), or 500 nm (**Claim 28**); the carbon nanotubes being charge stabilized (**Claim 30**); a mixing time in the bath sonicator being at least about 2 hours (**Claim 38**), 4 hours (**Claim 39**), 8 hours (**Claim 40**), or between about 16 and about 24 hours (**Claim 41**); the bath sonicator having a power in the range of from about 5 watts to about 150 watts (**Claim 42**); the bath sonicator having a frequency in the range of from about 20 kHz to about 75 kHz (**Claim 43**); the mixing time being selected to give rise to the mean length of individual SWNTs being at least about 300 nm (**Claim 48**) or 500 nm (**Claim 49**); the concentration of surfactant being less than the critical micelle concentration (**Claim 51**); nor electronic properties of the dispersed carbon nanotubes being essentially the same as the electronic properties of the carbon nanotubes prior to mixing (**Claim 52**).

20. With regard to **Claims 1, 4-17, 31-34, 37 and 44**, the structure of commercially-available polystyrene sulfonate is well-known in the art, as evidenced by Zaneveld (Zaneveld, paragraphs [0025]-[0027], in particular). Zaneveld discloses that polystyrene sulfonate has a high solubility in water and is available as a sodium salt, alkali metal salt, alkaline earth salt, and/or amine salt (Zaneveld, paragraphs [0025]-[0027], in particular). Zaneveld discloses that sodium polystyrene sulfonate has the following structure:




(Zaneveld, paragraph [0025], in particular).

21. Thus, the structure of polystyrene sulfonate, as evidenced by Zaneveld, clearly contemplates the fundamental polymer structure (aromatic group, alkyl chain and charged head group) repeating indefinitely ("n") and including alkaline salts thereof.

22. With regard to **Claim 9**, while O'Connell does not explicitly disclose the aromatic group capable of pi-like stacking onto the surface of the carbon nanotubes, there is no reason to believe the aromatic group of the polystyrene sulfonate of O'Connell would not be capable of pi-like stacking onto the surface of the carbon nanotubes. Thus, without evidence to prove otherwise, the aromatic group of the polystyrene sulfonate of O'Connell would inherently be capable of pi-like stacking onto the surface of the carbon nanotubes.

23. With regard to **Claim 14**, while the aforementioned applied art does not explicitly disclose a plurality of alkyl groups bonded to the aromatic group, if the fundamental polymer structure (aromatic group, alkyl chain and charged head group) repeats, each time the structure repeats, each new alkyl group would be

an alkyl group bonded directly to an aromatic group and bonded indirectly to another aromatic group.

24. With regard to **Claims 25, 26 and 28**, an expected mean length of single SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such mean length varies. Since the mean length is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable mean length of single SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

25. With regard to **Claim 30**, the claimed limitation would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The carbon nanotubes of the aforementioned applied art would inherently be charge stabilized since there is no teaching otherwise. Accordingly, the burden shifts to Applicants to show that charge stabilized carbon nanotubes would not be present in the composition of the aforementioned applied art.

26. With regard to **Claims 38-41 and 47-49**, expected mixing times, mean lengths of individual SWNTs, and number percentages of individual SWNTs are result effective variables since one of ordinary skill in the art would expect different properties in the process and resulting product as such times, lengths, and number percentages vary. Since mixing times, mean lengths, and number percentages are result effective variables, it is within the skill of one of ordinary

skill in the art to develop suitable mixing times and corresponding mean lengths and number percentages of individual SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

27. With regard to **Claims 42 and 43**, sonicator power and sonicator frequency are result effective variables since one of ordinary skill in the art would expect different properties in the process and resulting product as such parameters vary. Since sonicator power and sonicator frequency are result effective variables, it is within the skill of one of ordinary skill in the art to develop a suitable bath sonicator power and a suitable bath sonicator frequency. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

28. With regard to **Claim 51**, an expected component amount is a result effective variable since one of ordinary skill in the art would expect different properties in the process and resulting product as such amount varies. Since the amount is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable surfactant concentration. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

29. With regard to **Claim 52**, the claimed limitation would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The electronic properties of the dispersed carbon nanotubes of the aforementioned applied art would inherently be essentially the same as the electronic properties of the carbon nanotubes prior to mixing since

there is no teaching otherwise. Accordingly, the burden shifts to Applicants to show that the electronic properties of the dispersed carbon nanotubes would not be essentially the same as the electronic properties of the carbon nanotubes prior to mixing in the process of the aforementioned applied art.

30. **Claims 1-13, 15-30, 35 and 36** are rejected under 35 U.S.C. 103(a) as obvious over Rohrbaugh et al. (US 2002/0028288 A1) in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1).

31. With regard to **Claims 1-13 and 15-18**, Rohrbaugh discloses a dispersion comprising an aqueous medium; nanotubes; and a surfactant comprising sodium dodecylbenzene sulfonate (Rohrbaugh, Abstract, paragraphs 0044-0046; 0073-0130; 0141, in particular). The difference between the dispersion of Rohrbaugh and that of **Claim 1** is Rohrbaugh discloses nanotubes, but not carbon nanotubes.

32. With regard to **Claims 1-13 and 15-18**, it is well-known in the art that $C_n$ alkyl benzene sulfonates can be used as surfactants to disperse carbon nanotubes, as evidenced by Blanchet-Fincher (Blanchet-Fincher, US 7,033,525 B2: col. 3, lines 14-36; Example 1; Claims 1-3, in particular; US 2004/0065970 A1: paragraphs 0025-0026; Example 1; Claims 1-4, in particular; WO 02/080195 A1: page 3, lines 6-11 and 35-38; page 4, lines 1-15 and 29-30; page 5, lines 14-28; page 7, lines 15-22; page 9, lines 15-18; Example 1; Claims 1-4, in particular). Blanchet-Fincher discloses carbon nanotubes and a surfactant comprising dodecylbenzenesulfonic acid (Blanchet-Fincher, US 7,033,525 B2:

col. 3, lines 14-36; Example 1; Claims 1-3, in particular; US 2004/0065970 A1: paragraphs 0025-0026; Example 1; Claims 1-4, in particular; WO 02/080195 A1: page 3, lines 6-11 and 35-38; page 4, lines 1-15 and 29-30; page 5, lines 14-28; page 7, lines 15-22; page 9, lines 15-18; Example 1; Claims 1-4, in particular). Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the product disclosed by Rohrbaugh with the carbon nanotubes as taught by Blanchet-Fincher because one of ordinary skill in the art could have pursued the known potential nanotube options within his or her technical grasp with a reasonable expectation of success.

33. While the aforementioned applied art does not explicitly disclose the surfactant capable of non-covalently adhering to said carbon nanotubes (**Claim 3**); nor the aromatic group being capable of π–like stacking onto the surface of carbon nanotubes (**Claim 9**), these claimed limitations would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The surfactant of the aforementioned applied art would inherently be capable of non-covalently adhering to said carbon nanotubes, and the aromatic group would inherently be capable of π–like stacking onto the surface of carbon nanotubes to no less an extent than that of the instant application since Rohrbaugh discloses the same dispersion as that of the instant application. Accordingly, the burden shifts to Applicants to show that

non-covalent adhesion and π–like stacking would not occur in the dispersion of the aforementioned applied art.

34. The aforementioned applied art does not disclose the concentration of dispersed carbon nanotubes being between about 0.001 mg/mL and about 500 mg/mL (**Claim 19**), at least 0.5 mg/mL (**Claim 20**), or at most 30 mg/mL (**Claim 21**); the single wall carbon nanotubes including individual single wall carbon nanotubes (**Claims 22-25 and 28**); the number percentage of individual SWNTs being at least 50 percent (**Claims 22 and 27**), 75 percent (**Claim 23**), or 90 percent (**Claim 24**); the mean length of individual SWNTs being at least about 120 nm (**Claim 25**), 300 nm (**Claim 26**), or 500 nm (**Claim 28**); the weight ratio of carbon nanotubes to surfactant being in the range from about 5 : 1 to about 1 : 10 (**Claim 29**); the carbon nanotubes being charge stabilized (**Claim 30**); the aqueous liquid phase comprising at least about 50 wt% water (**Claim 35**); or the aqueous liquid phase comprising up to about 50 wt% of a solvent different than water (**Claim 36**).

35. With regard to **Claim 30**, the claimed limitation would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The carbon nanotubes of the aforementioned applied art would inherently be charge stabilized since there is no teaching otherwise. Accordingly, the burden shifts to Applicants to show that charge

stabilized carbon nanotubes would not be present in the composition of the aforementioned applied art.

36. With regard to **Claims 19-21, 29, 35 and 36**, an expected component amount or ratio is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such amount or ratio varies. Since the amount/ratio is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable dispersed carbon nanotube concentration, weight ratio of carbon nanotubes to surfactant, or solvent component amount. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

37. With regard to **Claims 22-24 and 27**, an expected number percentage of individual SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such number percentage varies. Since the number percentage is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable number percentage of individual SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

38. With regard to **Claims 25, 26 and 28**, an expected mean length of single SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such mean length varies. Since the mean length is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable mean length of single SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

39. The prior art date of a reference under 35 U.S.C. 102(e) may be the international filing date if the international application was filed on or after

November 29, 2000, designated the United States, and was published by WIPO under (PCT) Article 21(2) in the English language. US 2004/0065970 A1, now patented as US 7,033,525 B2, is a national stage entry of PCT/US02/05486 (published as WO 02/080195 A). WO 02/080195 A was filed after November 29, 2000 (February 12, 2002), designated the United States, and was published by WIPO under (PCT) Article 21(2) in the English language.

40. **Claims 1-13, 15-30, 35 and 36** are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiang (US 5,648,523) in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1).

41. With regard to **Claims 1-13 and 15-18**, Chiang discloses a dispersion comprising an aqueous medium; fullerenes; and a surfactant comprising sodium dodecylbenzene sulfonate (Chiang, col. 10, Example 2, in particular). The difference between the dispersion of Chiang and that of **Claim 1** is Chiang discloses fullerenes instead of carbon nanotubes.

42. With regard to **Claims 1-13 and 15-18**, it is well-known in the art that $C_n$ alkyl benzene sulfonates can be used as surfactants to disperse carbon nanotubes (carbon nanotubes are a type of fullerene), as evidenced by Blanchet-Fincher (Blanchet-Fincher, US 7,033,525 B2: col. 3, lines 14-36; Example 1; Claims 1-3, in particular; US 2004/0065970 A1: paragraphs 0025-0026; Example 1; Claims 1-4, in particular; WO 02/080195 A1: page 3, lines 6-11 and 35-38; page 4, lines 1-15 and 29-30; page 5, lines 14-28; page 7, lines 15-22; page 9, lines 15-18; Example 1; Claims 1-4, in particular). Blanchet-Fincher is applied as

above. Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the product disclosed by Chiang with the carbon nanotubes as taught by Blanchet-Fincher because one of ordinary skill in the art could have pursued the known potential fullerene options within his or her technical grasp with a reasonable expectation of success.

43. While the aforementioned applied art does not explicitly disclose the surfactant capable of non-covalently adhering to said carbon nanotubes (**Claim 3**); nor the aromatic group being capable of π–like stacking onto the surface of carbon nanotubes (**Claim 9**), these claimed limitations would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The surfactant of the aforementioned applied art would inherently be capable of non-covalently adhering to said carbon nanotubes, and the aromatic group would inherently be capable of π–like stacking onto the surface of carbon nanotubes to no less an extent than that of the instant application since Rohrbaugh discloses the same dispersion as that of the instant application. Accordingly, the burden shifts to Applicants to show that non-covalent adhesion and π–like stacking would not occur in the dispersion of the aforementioned applied art.

44. The aforementioned applied art does not disclose the concentration of dispersed carbon nanotubes being between about 0.001 mg/mL and about 500 mg/mL (**Claim 19**), at least 0.5 mg/mL (**Claim 20**), or at most 30 mg/mL (**Claim**

**21**); the single wall carbon nanotubes including individual single wall carbon nanotubes (**Claims 22-25 and 28**); the number percentage of individual SWNTs being at least 50 percent (**Claims 22 and 27**), 75 percent (**Claim 23**), or 90 percent (**Claim 24**); the mean length of individual SWNTs being at least about 120 nm (**Claim 25**), 300 nm (**Claim 26**), or 500 nm (**Claim 28**); the weight ratio of carbon nanotubes to surfactant being in the range from about 5 : 1 to about 1 : 10 (**Claim 29**); the carbon nanotubes being charge stabilized (**Claim 30**); the aqueous liquid phase comprising at least about 50 wt% water (**Claim 35**); or the aqueous liquid phase comprising up to about 50 wt% of a solvent different than water (**Claim 36**).

45. With regard to **Claim 30**, the claimed limitation would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The carbon nanotubes of the aforementioned applied art would inherently be charge stabilized since there is no teaching otherwise. Accordingly, the burden shifts to Applicants to show that charge stabilized carbon nanotubes would not be present in the composition of the aforementioned applied art.

46. With regard to **Claims 19-21, 29, 35 and 36**, an expected component amount or ratio is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such amount or ratio varies. Since the amount/ratio is a result effective variable, it is within the skill of one of

ordinary skill in the art to develop a suitable dispersed carbon nanotube concentration, weight ratio of carbon nanotubes to surfactant, or solvent component amount. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

47. With regard to **Claims 22-24 and 27**, an expected number percentage of individual SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such number percentage varies. Since the number percentage is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable number percentage of individual SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

48. With regard to **Claims 25, 26 and 28**, an expected mean length of single SWNTs is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such mean length varies. Since the mean length is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable mean length of single SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

49. **Claims 14 and 31-34** are rejected under 35 U.S.C. 103(a) as being unpatentable over

(a) Rohrbaugh et al. (US 2002/0028288 A1) in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1) as applied to **Claim 1** above, and further in view of Wei et al. (US 6,899,947 B2); or alternatively,

(b) Chiang (US 5,648,523) in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1) as applied to **Claim 1** above, and further in view of Wei et al. (US 6,899,947 B2).

50. The aforementioned applied art does not disclose a plurality of alkyl groups being bonded to the aromatic group (**Claim 14**); said surfactant comprising at least two alkyl groups (**Claim 31**); said surfactant comprising at least two aromatic groups (**Claim 32**); said surfactant comprising at least two charged head groups (**Claim 33**); or said surfactant comprising at least two alkyl chains, at least two aromatic rings, at least two charged groups, or any combination thereof (**Claim 34**).

51. With regard to **Claims 14 and 31-34**, Wei discloses calixarene surfactants for dispersing nanoparticles (Wei, "Abstract;" col. 1, lines 48-60; col. 3, lines 38-67; col. 4, lines 1-9; Fig. 1A, in particular).

52. Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to modify the dispersion of the aforementioned applied art with the calixarene surfactants of Wei in order to obtain an inexpensive and robust dispersion (Wei, col. 3, lines 38-51, in particular).

53. **Claim 14** is rejected under 35 U.S.C. 103(a) as being unpatentable over O'Connell et al. (*Chemical Physics Letters*) in view of Zaneveld et al. (US 2002/0114776 A1) as applied to **Claim 1** above, and further in view of Wei et al. (US 6,899,947 B2).

54. The aforementioned applied art does not explicitly disclose a plurality of alkyl groups being bonded to the aromatic group (**Claim 14**).

55. With regard to **Claim 14**, Wei is applied as above.

56. Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to modify the dispersion of the aforementioned applied art with the calixarene surfactants of Wei in order to obtain an inexpensive and robust dispersion (Wei, col. 3, lines 38-51, in particular).

57. **Claims 37-54** are rejected under 35 U.S.C. 103(a) as being unpatentable over Lobovsky et al. (US 2002/0113335 A1) in view of

(a) Rohrbaugh et al. (US 2002/0028288 A1), and further in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1); or alternatively,

(b) Chiang (US 5,648,523), and further in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1); or alternatively,

(c) O'Connell et al. (*Chemical Physics Letters*), and further in view of Zaneveld et al. (US 2002/0114776 A1).

58. With regard to **Claim 37**, Lobovsky discloses a method of preparing a dispersion of carbon nanotubes comprising mixing an aqueous medium, carbon nanotubes, and a surfactant comprising a sodium alkyl sulphate with an alkyl group having from 8 to 30 carbon atoms, such as sodium dodecyl sulphate in a low-power, high-frequency bath sonicator (Lobovsky, page 3, paragraph 0024; page 4, paragraph 0042; page 5, paragraph 0050; "Example 1;" and Fig. 3, in

particular). The difference between the process of Lobovsky and that of **Claims 37 and 44** is Lobovsky does not disclose a surfactant comprising an aromatic group or an alkaline salt of a $C_n$ alkyl benzene sulfonate, where n is between about 8 and about 16.

Paragraph 59 is limited to the rejection in view of Rohrbaugh

59. With regard to **Claims 37 and 44**, Rohrbaugh discloses a dispersion comprising an aqueous medium; nanotubes; and a surfactant comprising sodium dodecylbenzene sulfonate (Rohrbaugh, Abstract, paragraphs 0044-0046; 0073-0130; 0141). It is well-known in the art that $C_n$ alkyl benzene sulfonates can be used as surfactants to disperse carbon nanotubes, as evidenced by Blanchet-Fincher (Blanchet-Fincher, US 7,033,525 B2: col. 3, lines 14-36; Example 1; Claims 1-3, in particular; US 2004/0065970 A1: paragraphs 0025-0026; Example 1; Claims 1-4, in particular; WO 02/080195 A1: page 3, lines 6-11 and 35-38; page 4, lines 1-15 and 29-30; page 5, lines 14-28; page 7, lines 15-22; page 9, lines 15-18; Example 1; Claims 1-4, in particular). Blanchet-Fincher discloses carbon nanotubes and a surfactant comprising dodecylbenzenesulfonic acid (Blanchet-Fincher, US 7,033,525 B2: col. 3, lines 14-36; Example 1; Claims 1-3, in particular; US 2004/0065970 A1: paragraphs 0025-0026; Example 1; Claims 1-4, in particular; WO 02/080195 A1: page 3, lines 6-11 and 35-38; page 4, lines 1-15 and 29-30; page 5, lines 14-28; page 7, lines 15-22; page 9, lines 15-18; Example 1; Claims 1-4, in particular). Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the dispersion disclosed by Rohrbaugh with the carbon nanotubes as taught by Blanchet-

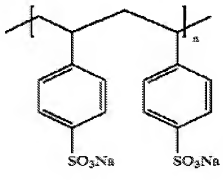
Fincher because one of ordinary skill in the art could have pursued the known potential nanotube options within his or her technical grasp with a reasonable expectation of success. Further, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the process of Lobovsky with the sodium dodecylbenzene sulfonate of the aforementioned applied art because one of ordinary skill in the art could have pursued the known potential surfactant options within his or her technical grasp with a reasonable expectation of success.

Paragraph 60 is limited to the rejection in view of Chiang

60. With regard to **Claims 37 and 44**, Chiang discloses a dispersion comprising an aqueous medium; fullerenes; and a surfactant comprising sodium dodecylbenzene sulfonate (Chiang, col. 10, Example 2, in particular). Blanchet-Fincher is applied as above. Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the dispersion disclosed by Chiang with the carbon nanotubes as taught by Blanchet-Fincher because one of ordinary skill in the art could have pursued the known potential fullerene options within his or her technical grasp with a reasonable expectation of success. Further, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the process of Lobovsky with the sodium dodecylbenzene sulfonate of the aforementioned applied art because one of ordinary skill in the art could have pursued the known potential surfactant options within his or her technical grasp with a reasonable expectation of success.

Paragraphs 61 and 62 are limited to the rejection in view of O'Connell

61. With regard to **Claims 37 and 44**, O'Connell discloses a dispersion comprising water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate (O'Connell, Abstract; page 265, 2nd column, 2nd paragraph; page 266; page 268, 2nd column; page 269; page 270, 1st column; page 271, "Conclusions," in particular). The structure of commercially-available polystyrene sulfonate is well-known in the art, as evidenced by Zaneveld (Zaneveld, paragraphs [0025]-[0027], in particular). Zaneveld discloses that polystyrene sulfonate has a high solubility in water and is available as a sodium salt, alkali metal salt, alkaline earth salt, and/or amine salt (Zaneveld, paragraphs [0025]-[0027], in particular). Zaneveld discloses that sodium polystyrene sulfonate has the following structure:




(Zaneveld, paragraph [0025], in particular).

62. Thus, the structure of polystyrene sulfonate, as evidenced by Zaneveld, clearly contemplates the fundamental polymer structure (aromatic group, alkyl chain and charged head group) repeating indefinitely ("n") and including alkaline salts thereof. Further, it would have been obvious to one of ordinary skill in the

art at the time of invention to modify the process of Lobovsky with the polystyrene sulfonate of the aforementioned applied art in order to overcome the restrictions normally associated with surfactants (O'Connell, page 265, in particular).

63. With regard to **Claims 42 and 43**, Lobovsky discloses the bath sonicator having a power of 30 watts and a frequency of 20 kHz (Lobovsky, "Example 1").

64. Lobovsky does not disclose a mixing time in the bath sonicator being at least about 2 hours (**Claim 38**), 4 hours (**Claim 39**), 8 hours (**Claim 40**), or between about 16 and about 24 hours (**Claim 41**); the concentration of dispersed carbon nanotubes being between about 0.001 mg/mL and about 500 mg/mL (**Claim 45**) or at least 0.5 mg/mL (**Claim 46**); the mixing time being selected to give rise to at least about 50 number percent of the dispersed carbon nanotubes being individual SWNTs (**Claim 47**); the mixing time being selected to give rise to the mean length of individual SWNTs being at least about 300 nm (**Claim 48**) or 500 nm (**Claim 49**); the single wall carbon nanotubes including individual single wall carbon nanotubes (**Claim 49**); the weight ratio of carbon nanotubes to surfactant being in the range of from about 5 : 1 to about 1 : 10 (**Claim 50**); the concentration of surfactant being less than the critical micelle concentration (**Claim 51**); electronic properties of the dispersed carbon nanotubes being essentially the same as the electronic properties of the carbon nanotubes prior to mixing (**Claim 52**); a step of electrophoretically separating the dispersed carbon nanotubes (**Claim 53**); nor the carbon nanotubes being separated according to length, shape, or any combination thereof (**Claim 54**).

Paragraphs 65-68 are limited to the rejection in view of O'Connell

65. With regard to **Claims 45 and 46**, O'Connell discloses polystyrene sulfonate can solubilize SWNT material up to 4.1 g/l (O'Connell, page 269, 2nd column, last paragraph, in particular).

66. With regard to **Claim 47**, O'Connell discloses most polymer-SWNT complexes consist of a single SWNT associated with the polymer (O'Connell, page 266, 2nd column, last paragraph; page 267, 1st column, 1st paragraph, in particular). Thus, while O'Connell does not explicitly disclose the mixing time being selected to give rise to at least about 50 number percent of the dispersed carbon nanotubes being individual SWNTs, the mixing time must have been sufficient to give rise to at least about 50 number percent of the dispersed carbon nanotubes being individual SWNTs.

67. With regard to **Claim 50**, O'Connell discloses the weight ratio of carbon nanotubes to polystyrene sulfonate being 2:1 for laser-oven material and 1:2 for HiPco material (O'Connell, page 270, 1st column, 1st paragraph, in particular).

68. With regard to **Claims 53 and 54**, O'Connell discloses electrophoretically separating the dispersed carbon nanotubes according to length (O'Connell, page 265, 2nd column, 1st full paragraph; 270, 2nd column, last paragraph; page 271, 1st column, 1st paragraph; Fig. 5, in particular).

Paragraph 69 is limited to the rejections in view of Rohrbaugh and Chiang

69. With regard to **Claim 49**, one of ordinary skill in the art would expect at least some individual single wall carbon nanotubes to be present in a dispersion

comprising water, single wall carbon nanotubes and surfactant (sodium dodecyl benzene sulfonate).

70. With regard to **Claim 52**, the claimed limitation would be inherent. For a reference which neither expressly describes or teaches the subject matter alleged to be anticipated, the reference must provide enough information to permit an inference that the subject matter is inherent. *Ex parte Garvin*, 62 USPQ 2d 1680 (BPAI 2001). The electronic properties of the dispersed carbon nanotubes of the aforementioned applied art would inherently be essentially the same as the electronic properties of the carbon nanotubes prior to mixing since there is no teaching otherwise. Accordingly, the burden shifts to Applicants to show that the electronic properties of the dispersed carbon nanotubes would not be essentially the same as the electronic properties of the carbon nanotubes prior to mixing in the process of the aforementioned applied art.

71. With regard to **Claims 45, 46, 50 and 51**, an expected component amount or ratio is a result effective variable since one of ordinary skill in the art would expect different properties in the product as such amount or ratio varies. Since the amount/ratio is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable dispersed carbon nanotube concentration, weight ratio of carbon nanotubes to surfactant, or surfactant concentration. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

72. With regard to **Claims 38-41 and 47-49**, expected mixing times, mean lengths of individual SWNTs, and number percentages of individual SWNTs are result effective variables since one of ordinary skill in the art would expect

different properties in the product as such times, lengths, and number percentages vary. Since mixing times, mean lengths, and number percentages are result effective variables, it is within the skill of one of ordinary skill in the art to develop suitable mixing times and corresponding mean lengths and number percentages of individual SWNTs. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

73. **Claims 53 and 54** are rejected under 35 U.S.C. 103(a) as being unpatentable over

(a) Lobovsky et al. (US 2002/0113335 A1) in view of Rohrbaugh et al. (US 2002/0028288 A1), and further in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1) as applied to **Claim 37** above, and further in view of Yamamoto et al. (*Journal of Physics D*); or alternatively,

(b) Lobovsky et al. (US 2002/0113335 A1) in view of Chiang (US 5,648,523), and further in view of Blanchet-Fincher et al. (US 7,033,525 B2, US 2004/0065970 A1, or WO 02/080195 A1) as applied to **Claim 37** above, and further in view of Yamamoto et al. (*Journal of Physics D*).

74. The aforementioned applied art does not disclose a step of electrophoretically separating the dispersed carbon nanotubes (**Claim 53**); nor the carbon nanotubes being separated according to length, shape, or any combination thereof (**Claim 54**).

75. With regard to **Claims 53 and 54**, Yamamoto discloses electrophoretically separating dispersed carbon nanotubes according to length (Yamamoto, whole document).

76. Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to try to modify the process of the aforementioned applied prior art with the electrophoretic separation of Yamamoto because one of ordinary skill in the art could have pursued the known potential separation options within his or her technical grasp with a reasonable expectation of success.

***Double Patenting***

77. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ

619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

78. **Claims 1, 3-13 and 15-18** are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 17-20 of copending Application No. 12/792963 in view of Rohrbaugh et al. (US 2002/0028288 A1).

79. Application No. 12/792963 discloses carbon nanotubes and a surfactant comprising an aromatic group, an alkyl group having from about 4 to about 30 carbon atoms, and a negatively charged head group, wherein the surfactant may comprise hexylbenzene sulfonate, octylbenzene sulfonate, dodecylbenzene sulfonate, hexadecylbenzene sulfonate, or any combination thereof. The difference between the product of Application No. 12/792963 and **Claim 1** is Application No. 12/792963 does not disclose the carbon nanotubes and surfactant further comprising an aqueous medium.

80. Rohrbaugh discloses a dispersion comprising an aqueous medium; nanotubes; and a surfactant comprising sodium dodecylbenzene sulfonate (Rohrbaugh, Abstract, paragraphs 0044-0046; 0073-0130; 0141). Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to modify the product of Application No. 12/792963 with the aqueous medium of Rohrbaugh in order to obtain a carbon nanotube dispersion.

This is a provisional obviousness-type double patenting rejection.

***Additional Prior Art***

The following prior art has not been used in a rejection, but is relevant to the instant application:

US 2003/0122111 A1 (now patented as US 7,060,241 B2)

US 2003/0122111 A1 discloses water soluble single-walled carbon nanotubes modified with polyvinyl pyrrolidone (US 2003/0122111 A1, paragraph 0131, in particular).

US 2003/0001141 A1 (now patented as US 7,250,569 B2)

US 2003/0001141 A1 discloses a dispersion comprising water, carbon nanotubes, and polyvinyl pyrrolidone (US 2003/0001141 A1, paragraph 0054, in particular).

US 2002/0068170 A1 (now patented as US 7,264,876 B2)

US 2002/0068170 A1 discloses a dispersion comprising water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate (US

2002/0068170 A1, paragraphs 0028; 0032; 0034-0036; 0038; 0041; 0048; 0054-0078; Claims 1 and 9, in particular).

US 2002/0048632 A1

US 2002/0048632 A1 discloses a dispersion comprising water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate (US 2002/0048632 A1, paragraph 0034, in particular).

US 2002/0046872 A1 (now patented as US 7,008,563 B2)

US 2002/0046872 A1 discloses a dispersion comprising water, single-walled carbon nanotubes, and polyvinyl pyrrolidone or polystyrene sulfonate (US 2002/0046872 A1, paragraph 0034, in particular).

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BRITTANY M. MARTINEZ whose telephone number is (571) 270-3586. The examiner can normally be reached on Monday-Friday 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Emily M. Le can be reached on (571) 272-0903. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

BMM
/Brittany M Martinez/
Examiner, Art Unit 1734

/Emily M Le/
Supervisory Patent Examiner, Art Unit 1734